MECHANICAL AND SEM ANALYSIS OF ARTIFICIAL COMET NUCLEUS SAMPLES

K. Thiel[1], H. Kochan[2], K. Roessler[3], E. Grün[4], G. Schwehm[5], H. Hellmann[2], P. Hsiung[3], G. Kölzer[1].

[1] Nuklearchemie, Universität Köln, D-5000 Köln, F.R. Germany

[2] Institut für Raumsimulation, DFVLR WB-RS, P.O. Box 90 50 58, D-5000 Köln, F.R. Germany

[3] Institut für Chemie, KFA, D-5170 Jülich, F.R. Germany

[4] Max-Planck-Institut für Kernphysik, D-6900 Heidelberg, F.R. Germany

[5] European Space Agency - ESTEC, NL-2200 Noordwijk, The Netherlands

As already reported in Ref.(1), since 1987 experiments dealing with comet nucleus phenomena are being carried out in the DFVLR simulation chambers. The main objective of these experiments is a better understanding of thermal behaviour, surface phenomena and especially the gas dust interaction.

As a function of different sample compositions and exposure to solar irradiation (Xenon-bulbs) crusts of different hardness and thickness were measured. The measuring device consists of a motor driven pressure foot (5 mm diameter), which is pressed into the sample. The applied compressive force is electronically monitored. Figure 1 shows typical stress distributions of an unirradiated and an irradiated sample. Normally the exposure time varies in the range of 2-4 hours with a solar irradiation intensity between 1 and 2.5 solar constants.

During one experiment in the big Space Simulator with a large mineral-ice sample of 30 cm diameter a penetrator was motor driven forced into a dummy target. After the experiment the irradiated sample was submitted to the same procedure. In the last case the formation of a loose dust mantle and a solid crust of 3-5 cm thickness below the surface was indicated by a relatively slow increase of the compressive force at the beginning and a steep increase when the crust was reached. After the penetration of the crust the compressive force dropped markedly.

At the end of the simulation experiment when the chamber was opened the sample was transferred into a liquid nitrogen bath to keep the sample at low temperature. To prevent freezing out of air humidity on the sample this liquid nitrogen bath was kept in a dry N_2-flooded glove box.

The structure of the crust and dust residuals is investigated by SEM-techniques. This was found to be strongly dependent on the mineral composition of the dust admixture in the artificial comet. Mainly phyllo- and neo-silicates (kaolinite, montmorillonite, olivine) are used with a maximum fraction of 10 % in 90 % water ice. Recent experiments include also CO_2-ice in concentrations around 10 %.

The SEM-investigations show that the microstructure of the residuals is dominated by the sample preparation method (see Ref.(1)). High admixtures of phyllosilicates result in millimeter sized spherules of high regularity. Increasing concentrations of neosilicate lead to dust residuals similar to Brownlee particles. High resolution video records of the sample surface during the irradiation indicates that the dust emission mechanism is strongly related to the consistency of the uppermost surface layer.

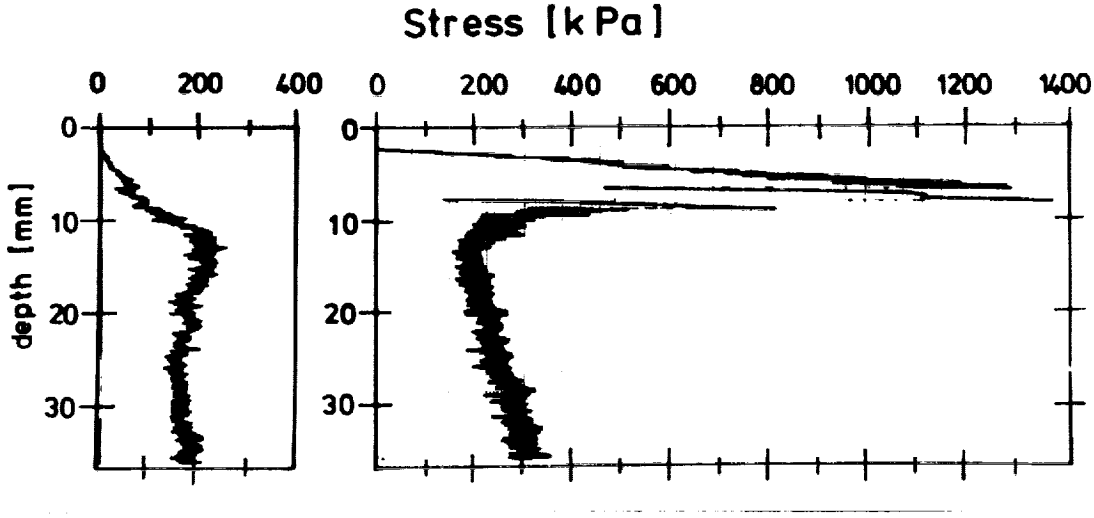

Fig.1 Stress-depth profiles of an unirradiated (left) and an irradiated (right) model comet.

Reference

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